March 15, 1849.

The MARQUIS OF NORTHAMPTON, V.P., in the Chair.

A paper was read, entitled "Researches in Physical Geology." Part II. By Henry Hennessy, Esq. Communicated by Major Beamish, F.R.S.

In this communication the author states that, having in Part I. (read to the Society in December 1846) endeavoured, by generalizing the hypothesis on which is usually founded the theory of the earth's figure, not only to improve that theory, but also to establish a secure basis for researches into the changes which may have taken place, within and at the surface of the earth, during the epochs of its geological history, his object here is to discover relations between the interior structure of the earth and phenomena observed at its surface, and also the effects of the reaction of the fluid nucleus, described in Part I., upon the solid crust. This memoir is divided into sections, each containing a distinct investigation; and the statement of the geological results is given at the end.

I. *The Pressures of the Shell and Nucleus at their surface of contact.*

In the investigation of these pressures the earth is supposed to consist of a nucleus of fluid matter inclosed in a solid shell, the inner and outer surfaces of which are spheroidal, but nearly spherical; and both shell and nucleus are supposed to consist of strata varying in density according to some unknown inverse law of the radii. The pressure at the inner surface of the shell is conceived to be due to a constant pressure, which is the same for every point, and a variable pressure, arising from the difference in form of the surface of the nucleus and inner surface of the shell. On these suppositions, simple expressions for the pressure on any stratum of the nucleus and on the shell's inner surface are deduced.

II. *The Variation of Gravity at the earth's surface.*

The author does not assume in this investigation that the laws of arrangement of the particles composing the shell and the nucleus are necessarily the same; so that the expression which he obtains for gravity at any point on the earth's surface, besides being a function of the latitude of that point, and of the radii and ellipticities of the shell's inner and outer surfaces, contains functions depending on the constitution of the shell and nucleus. He states that this expression for gravity is not merely speculative, but that it will be found to assist in explaining certain apparent anomalies detected by observation in the variation of gravity at the earth's surface, as well as in pointing out the limits assigned by observation to the thickness of the crust.

III. *The Laws of Density of the Shell and Nucleus.*

According to the author's views in a subsequent section, it appears that the solidification of the earth could not proceed simulta-

neously from the centre towards the surface, and from the surface towards the centre. He therefore, in determining the laws of density of the shell and the nucleus, restricts his investigations to the latter case, in which the solidification proceeds from the surface towards the centre.

IV. *The Forms of the Strata of the Shell.*

The author conceives a surface to exist which may be called the effective surface of separation of the perfect fluid of the nucleus and the imperfectly fluid portion adhering to the shell, the form of which surface will depend on the pressures which the fluid exerts. As it may be shown that the pressure of the perfect fluid will not be constant, the surface of separation will tend to assume a form different from that of the inner surface of the shell. If we admit that the matter composing the nucleus becomes denser in assuming the solid state, the author concludes that the inner surface of each stratum added to the shell will be more oblate than its outer surface; and that thus the tendency will always be to render the inner surface of the shell more and more oblate. He then deduces an expression for the ellipticity of the fluid surface.

V. *The principal Moments of Inertia of the Earth.*

From his investigations the author concludes that, as the thickness of the shell increases, the difference between the greatest and the least moment of inertia of the earth also increases; which conclusion is independent of any knowledge of the absolute laws of density of the earth's interior.

VI. *On the existence of a Solid Nucleus within the Earth.*

The conclusion arrived at here is, that if a solid nucleus existed, as the pressure on it would be continually diminishing, while its temperature would remain nearly constant, this nucleus, instead of increasing in magnitude, would tend to return to its original fluid state.

VII. *The directions of the Fissures in the Shell which might be produced by the action of the pressures in Section* I.

The author states that the tendency of the variable pressure is in the first instance to produce fissures parallel to the equator; that when such a fissure was once commenced the tendency would be to propagate it along a parallel of latitude, until the force of the tensions became sufficiently lessened by the separation of the extended portion of the shell; and that similar fissures would be formed simultaneously and symmetrically on each side of the equator. Subsequently, as may readily be deduced from Mr. Hopkins's investigations, the tendency will be to form fissures at right angles to those previously existing. If, however, the constant pressure were far greater than the variable, the directions of the fissures would be governed chiefly by accidental causes; but if a fissure commenced, it

would continue to be propagated in the great circle coinciding with its first direction, unless accidental causes should alter its course.

VIII. *On the existence of a Zone of least disturbance in the Shell.*

The author investigates analytically the position of this zone, and from the results of his investigation, points out the conditions under which it will exist, and also the consequences that will follow from its non-existence.

IX. This section is devoted to the calculation of some of the constants contained in the formulæ of the preceding sections.

The following are the geological deductions from the foregoing investigations:—

1. The stability of the axis of rotation of the earth will progressively increase during the process of solidification.

2. By employing the values of the constants obtained in Section IX., it appears that the thickness of the earth's crust cannot be less than 18 miles, and cannot exceed 600 miles.

3. The earth's primitive ellipticity, when entirely fluid, was less than its present ellipticity; but their difference may be neglected.

4. If a zone of least disturbance existed near the parallel of mean pressure, the directions of great lines of elevation should be in general parallel, or perpendicular to the equator. Its non-existence there, which observation seems to show, proves at least that the variable pressure did not predominate over the constant. Since, as yet, observation goes to prove that such a zone does not exist on the earth's surface, we must provisionally conclude that the constant pressure greatly predominated over the variable, and, consequently, that the directions of the lines of elevation must be comparatively arbitrary.

5. That great friction and pressure exist at the surface of contact of the nucleus and shell, is shown from the conclusions arrived at in Section IV., combined with the important result obtained by Mr. Hopkins in his second memoir on Physical Geology (Phil. Trans. 1840, p. 207).

6. The amount of elastic gases given off from the surface of the nucleus rapidly decreases as the thickness of the shell increases.

7. The expression obtained for the variation of gravity shows that, if the angular velocity of rotation of the earth remained unchanged, the waters on its surface would tend to accumulate towards the equator, for the increase of gravity, in going from the equator to the poles, would be less according as the shell's thickness increased.

March 22, 1849.

The Very Rev. The DEAN OF WESTMINSTER, Vice-President, in the Chair.

A paper was read, entitled "An Account of the Aurora Borealis